Vitamin C

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Medical Biochemistry & Molecular Biology

Lecture Key points

1. Mechanism of action of vitamin C ,functions, and its role of collagen synthesis
2. Clinical disorders to vitamin C deficiency.

INTENDED LEARNING OBJECTIVES (ILO)

By the end of this lecture , the student will be able to:

1. **Discuss mechanism of action of vitamin C and its role of collagen synthesis**
2. **Correlate clinical disorders to vitamin C deficiency.**

Case scenario

A 4-year-old boy was brought for consultation for hematuria, edema of lower extremities as well as swollen right leg. He was the 12the born in a poor family, where one previous child died from malnutrition and dehydration in the period of infancy. The child was fed only with cow's milk and biscuits.

At admission the baby was afebrile, pale, and malnourished; his hair was dry and cracked. Clinical evaluation showed no organomegaly, no neurological signs, gingival bleeding

http://www.namrata.co/case-study-scurvy

Case scenario

Laboratory findings were as follows

Red Blood Cell Count 3.5 million/mm^3

Hemoglobin (Hb) 7 g/dl

Haemtocrit (Hct) 30%

Serum Iron low

Liver function

Ultrasound of kidney was

Doppler of blood vessels of both legs was normal which excluded thrombophlebitis. Swelling of the right leg indicated radiological investigation. Massive subperiosteal hematoma on the right femur, dilatated metaphyses and general osteoporosis had been present on the radiogram.

What is the probable diagnosis for this child ?

What is the suspected diagnosis?

Vitamins

- **Vitamins are organic nutrients that are required to small quantities for a variety of biochemical functions.**
- **They cannot be synthesized by the body in adequate amounts and must therefore be supplied in diet.**
- **Absence or relative deficiency of vitamins in diet leads to characteristic deficiency states and diseases.**

Classifications of vitamins

Vitamins fall into 2 classes according to their solubility, fat soluble and water soluble

Vit C

(L-ascorbic acid)

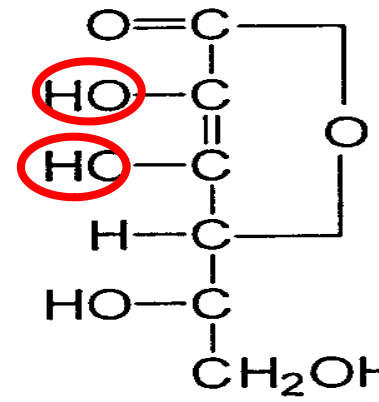
- **It is synthesized from glucose** by the **uronic acid pathway (not in human)**
- **Sources:**

Fresh fruits and Vegetables

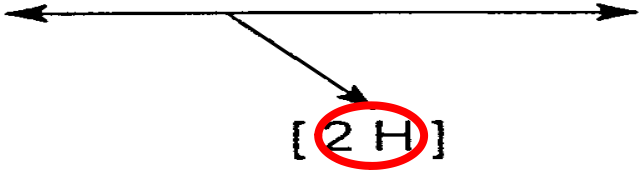
Must be taken in diet

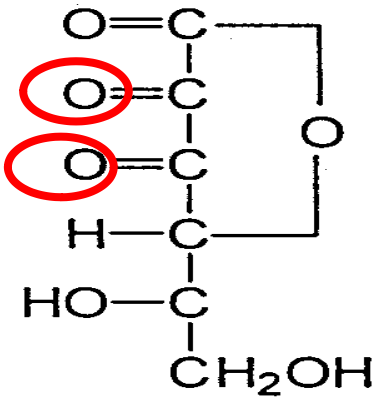
It destroyed by storage of food & **cooking (heat) & freezing**

Active form of vitamin C



L- Ascorbic acid
Reduced Vitamin C





L-DehydroAscorbic acid
Oxidized Vitamin C

Vitamin C act as hydrogen donor

Active form

Functions of vitamin C

[A] Act as a reducing agent (hydrogen donor) in number of hydroxylation reactions (Coenzyme for hydroxylases):

(1) Hydroxylation of proline and lysine in collagen synthesis normal connective tissue (collagen) formation.

(2) Hydroxylation reactions necessary for corticosteroid synthesis in suprarenal gland

(3) Bile acid formation (7 α-hydroxylase step).

(4) Tyrosine catabolism and synthesis of norepinephrine and epinephrine.

Functions of vitamin C

B] Vitamin C reduces ferric (Fe^{+++}) to ferrous ion (Fe^{++}) in stomach and thus helps absorption of iron.

Decrease vitamin C (Scurvy) → decrease iron level

[C] Vitamin C acts as an antioxidant:

antioxidant vitamins (vitamins C, E, and β-carotene) → Prevention of chronic disease

D) Immunological function Of vitamin C

Vitamin C is thought to moderate colds by :

- Enhancing many immune cell (such as some leukocyte) functions and increase phagocytic function phagocytosis of virus or bacteria
- Destroying histamine, which causes many of a cold's symptoms.
- Increase immunoglobulin's synthesis

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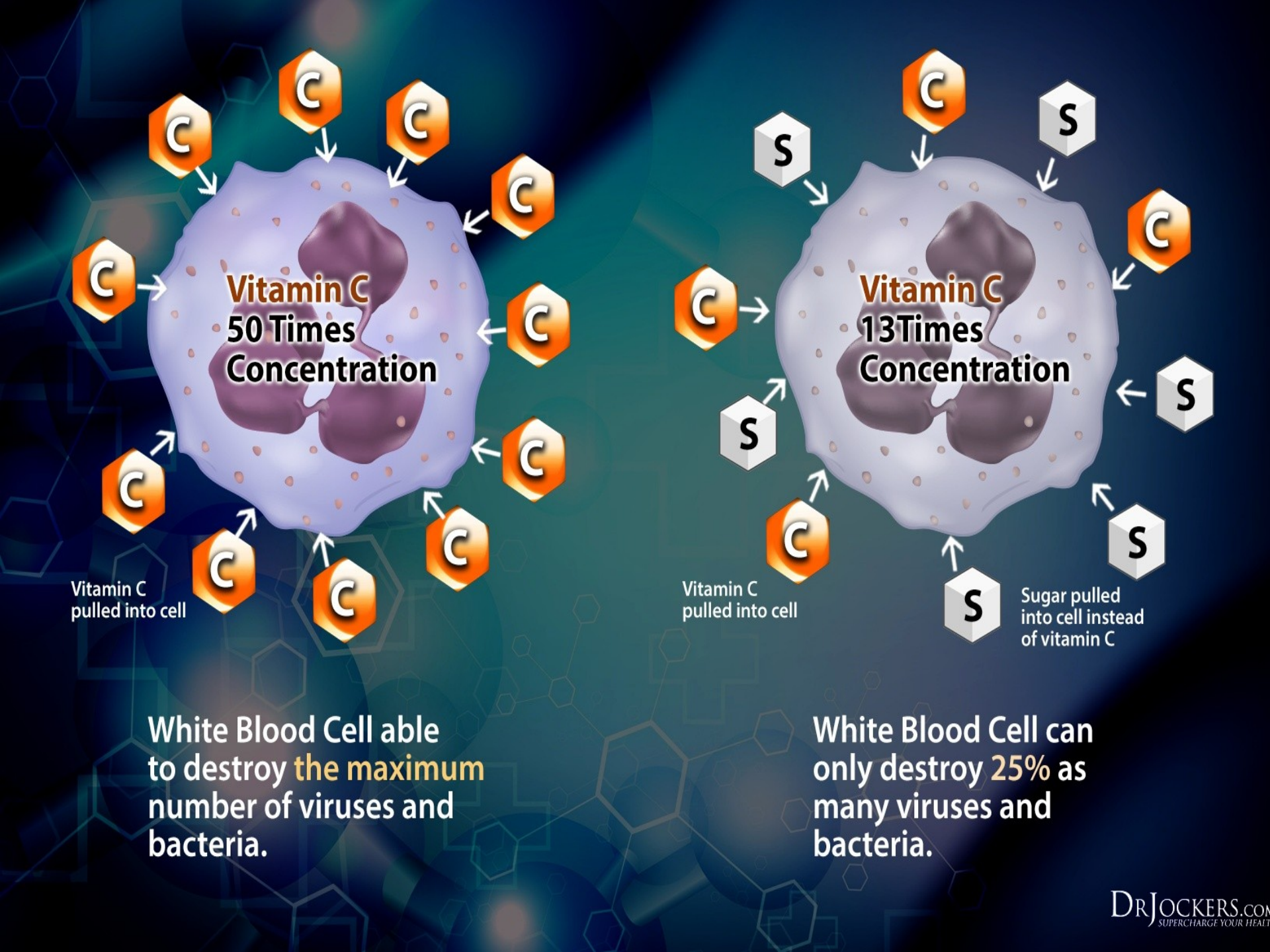

White Blood Cell able to destroy the maximum number of viruses and bacteria.

White Blood Cell can only destroy 25% as many viruses and bacteria.

E) Role of vitamin C in prevention of chronic diseases

- **Vitamin C is one of a group of antioxidants vitamins that includes (vitamins C, E, and β-carotene)** ⟶
- **Ascorbate (vitamin C) regenerates the functional, reduced form of vitamin E.**
- **Consumption of diets rich in these vitamins is associated with a decreased incidence of some chronic diseases, such as Diabetes ,coronary heart disease and certain cancers.**

Functions of vitamin C

A]Coenzyme for hydroxylases enzyme (reducing agent in hydroxylation reaction

1) Hydroxylation of proline and lysine in collagen synthesis normal connective tissue (collagen) formation.

(2)Hydroxylation reactions in corticosteroid biosynthesis

(3) Bile acid formation (7 α-hydroxylase step).

(4) Tyrosine catabolism and synthesis of norepinephrine and epinephrine.

B] Vitamin C reduces ferric (Fe^{+++}) to ferrous ion (Fe^{++}) in stomach and thus helps absorption of iron.

[C] Vitamin C acts as an antioxidant

antioxidant vitamins are: (vitamins C, E, and β-carotene)

Prevention of chronic disease

D] Immunological function

E] Prevention of chronic diseases

Vitamin C functions Quiz

Which one of the following enzymes need vitamin C as coenzyme?

A. Dehydregnase
B. Carboxylase
C. Mutase
D. Hydroxylase

Vitamin C Deficiency (scurvy):

due to **decreased** fresh fruit and vegetables in diet

Manifestations :

[A] Manifestations due to impaired hydroxylation of proline and lysine in collagen

(1) Delayed wound healing.

(2) loose teeth & sore and spongy gums bleeding gums.

(3) Swollen joints & Osteoporosis: due to inability to maintain collagenous matrix of bone easy fracture

(4) Easy bruising and subcutaneous hemorrhage

This is due to increase capillary fragili

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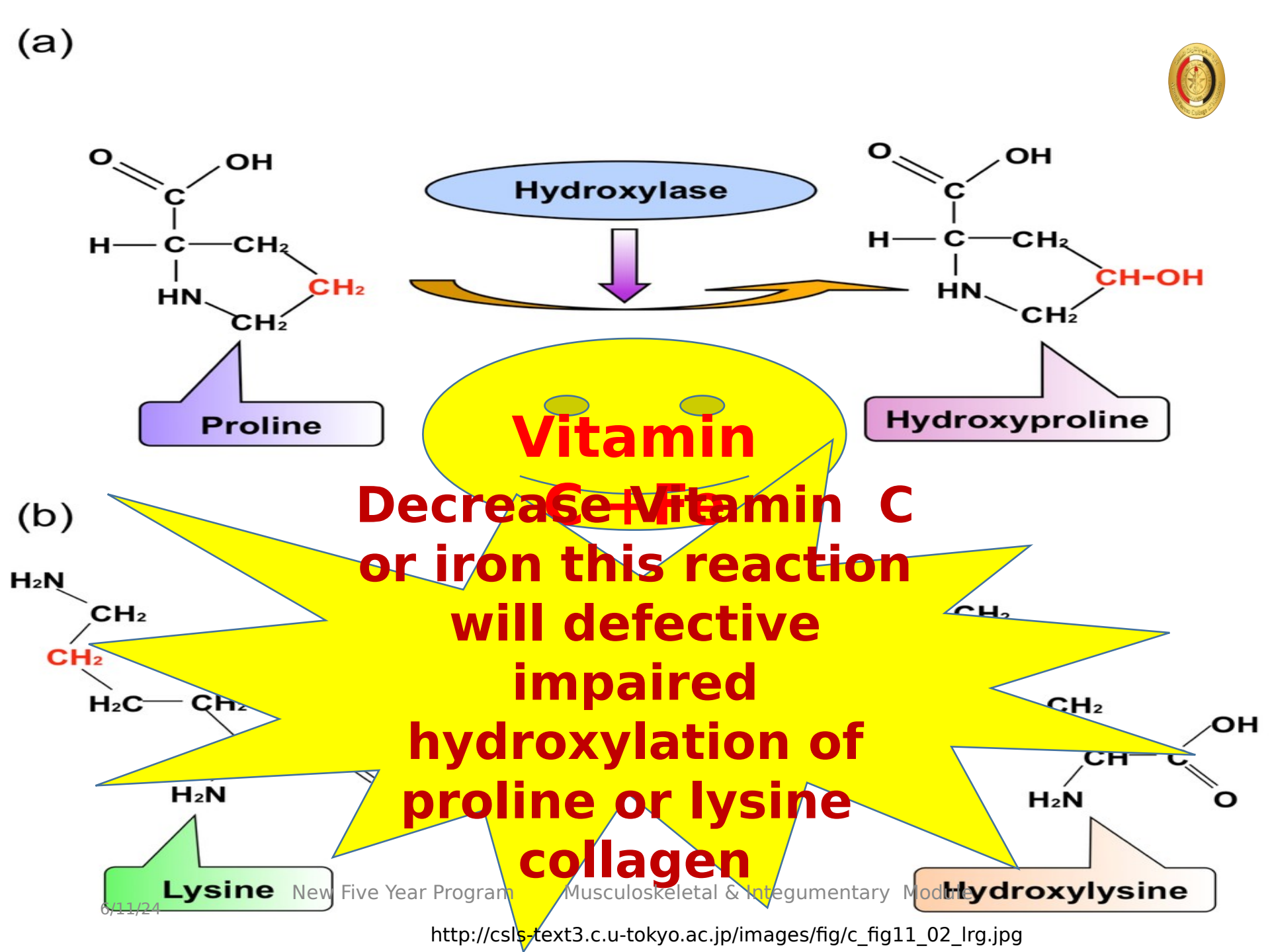

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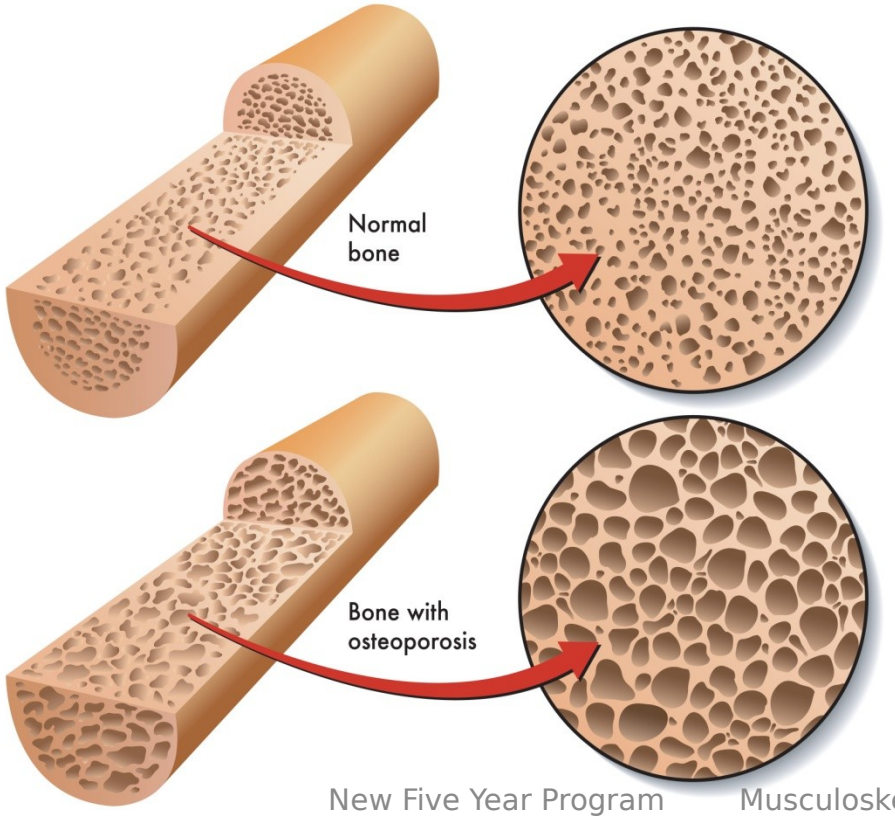

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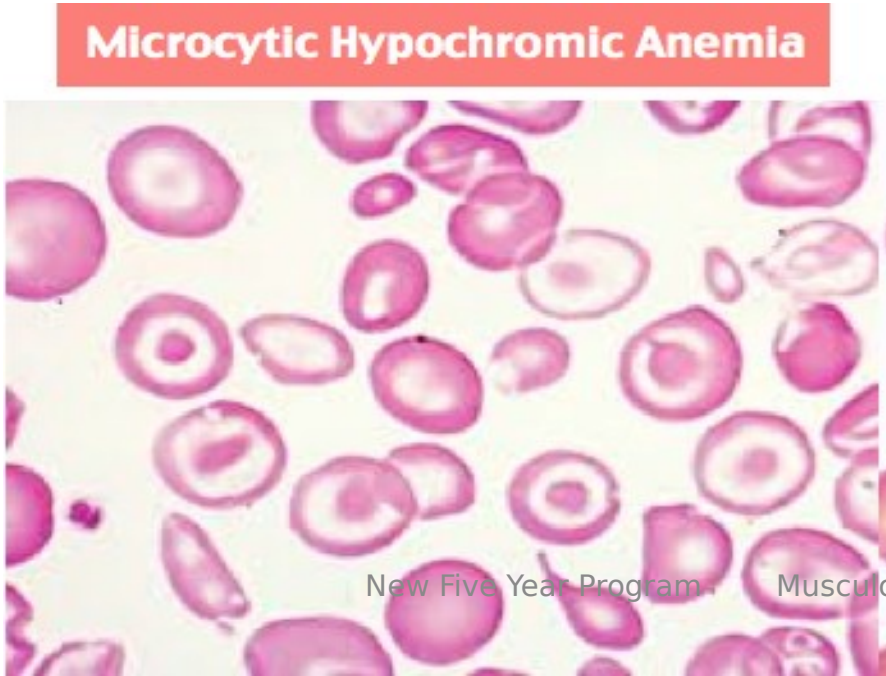
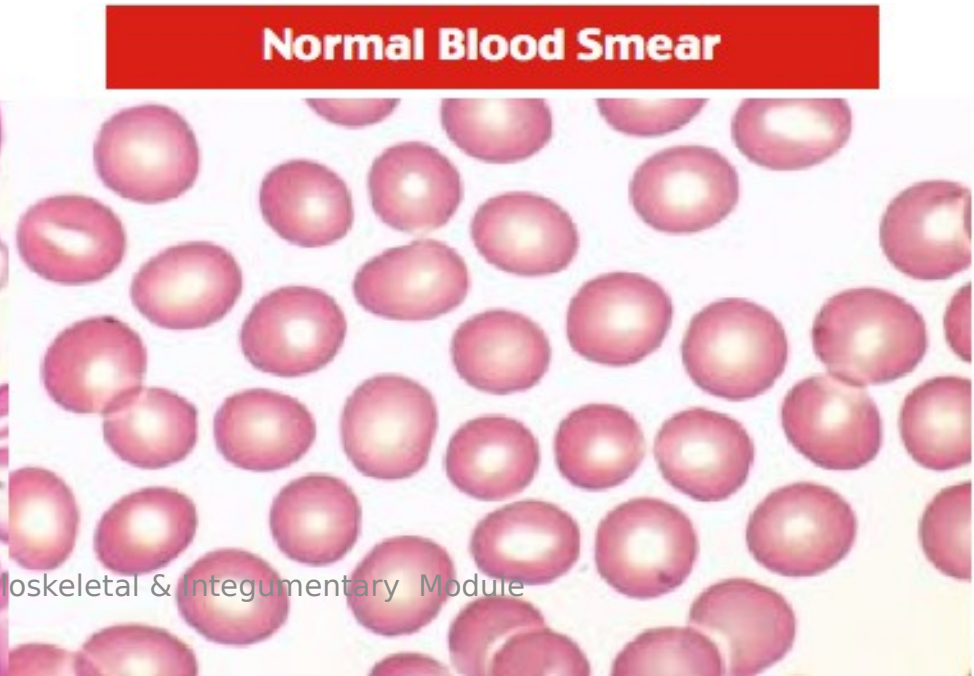
[B] Microcytic hypochromic anemia

may occur due to:

Explain?

- **Chronic blood loss**
- **Defective iron absorption.**

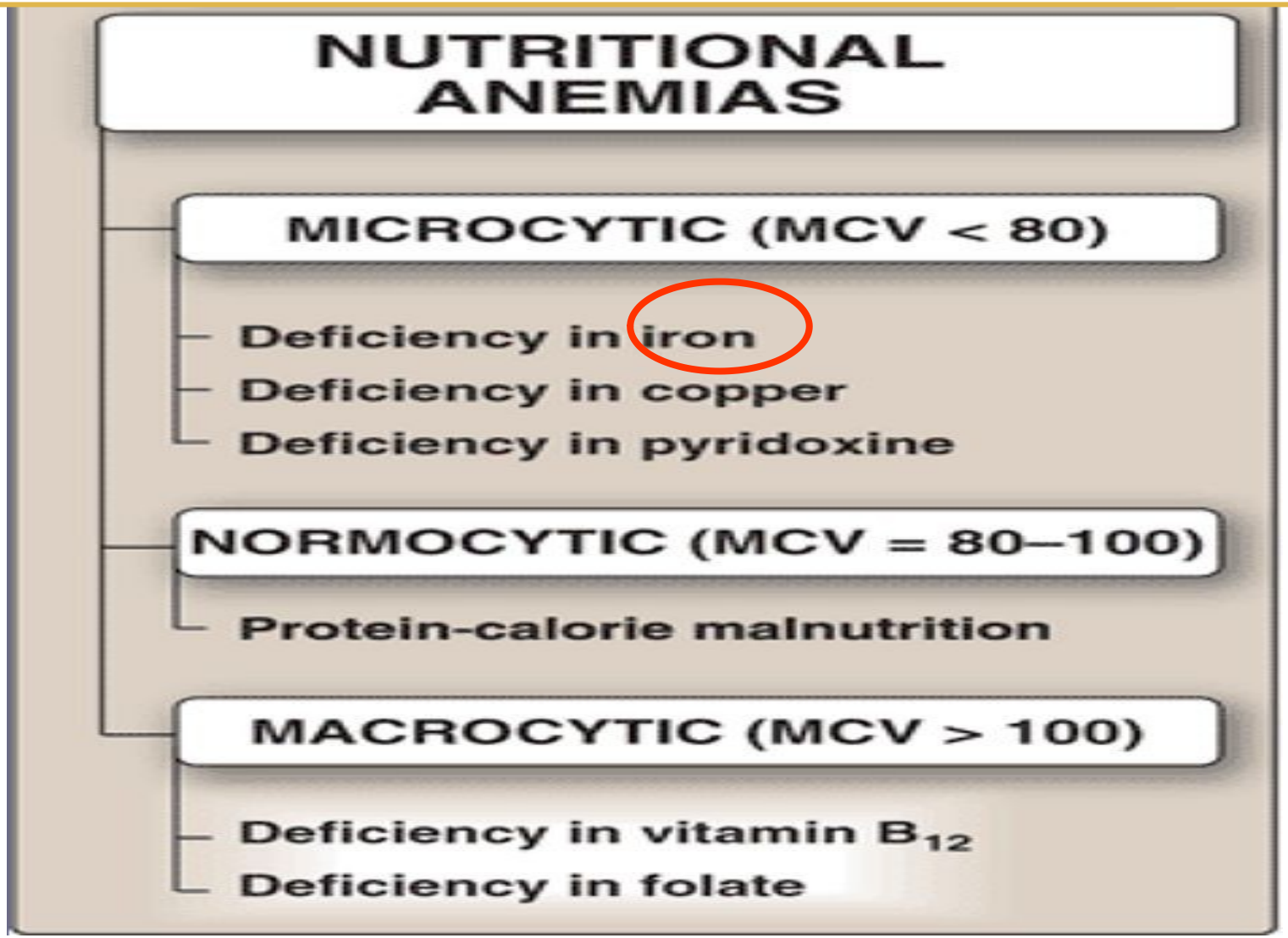




Nutritional anemias

- **Classification of nutritional anemia by cell size.**
- **The normal mean corpuscular volume (MCV) for people older than age 18 is between 80 and 100 µ;m3.**

Classification of nutritional anemias by RBCs cell size



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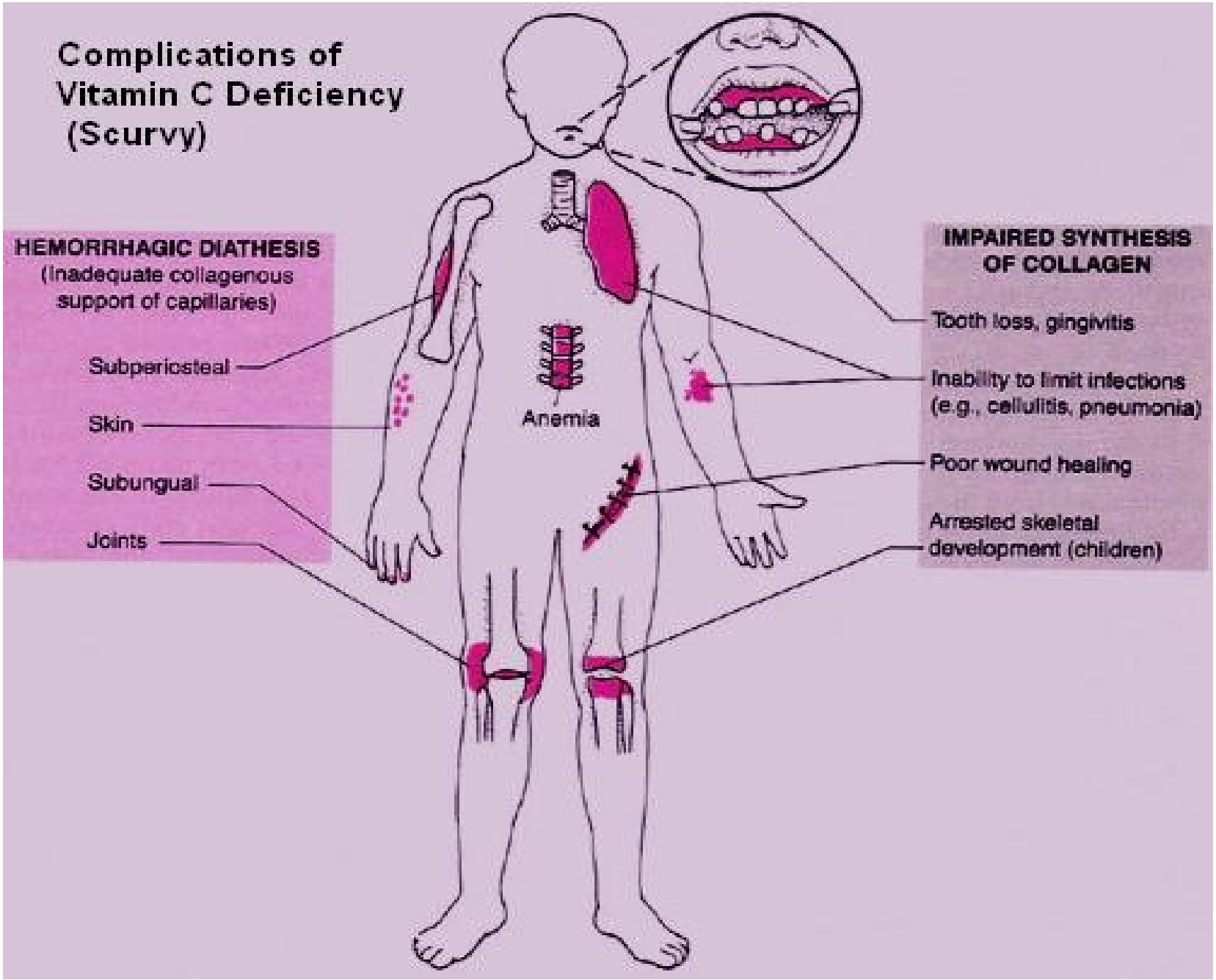

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Lecture Summary

1. functions of vitamin C and its role of collagen synthesis
2. Clinical disorders to vitamin C deficiency.

Lecture Quiz

Which one of the following vitamins is useful in coronary heart disease?

A. Vitamin D

B. Vitamin K

C. Vitamin C

D. Folic acid

Lecture Quiz

30) Out of the followings which vitamin increases the absorption of iron from the gut?

a) Vitamin D

b) Vitamin E

c) Vitamin C

d) Vitamin K

SUGGESTED TEXTBOOKS

- "Lippincott's Illustrated Reviews in Biochemistry" by P.C.Champe, R.A.Harvey and D.R.Ferrier
- "Harper's Biochemistry" by R.K.Murray, D.K.Granner, P.A. Mayes and V.W.Rodwell.
- Fundamentals of Clinical Chemistry (Tietz) Sixth
- "Textbook of Biochemistry with Clinical Correlations" by T.M.Devlin
- www.namrata.co- ***Biochemistry for medics***

Thank you

Dr/Amal El-Shal